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STUDIES OF ARTESIAN WATERS IN CHICAGO AND SURROUNDING TERRITORY

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INTRODUCTION

The rapid decrease in the artesian water supply of Chicago and the surrounding region was brought to the attention of the State Geological Survey in 1912, and arrangements were made to coöperate with the State Water Survey in a careful investigation. The field and laboratory work is now finished and a preliminary statement of some of the striking features is presented to the Illinois section. The following items relating to the Chicago area are considered briefly: underground water supply; water-bearing formations; artesian conditions; lowering of water table, and chemical quality of waters. Plate I illustrates the area concerned, and shows the variation in water table by means of 10-foot contours.

UNDERGROUND WATER SUPPLY

Northeastern Illinois has an underground water supply of great value to cities and small towns, and to industrial demands, in view of the fact that the streams are small and their waters are of poor quality.

Underground water is obtained from three kinds of wells: shallow wells in the surface formations, shallow rock wells, and deep rock wells which are artesian in character.

The first two groups are large producers of water only in isolated cases where the sand and gravel are very thick, and the rock is shallow and very porous. The deep wells, however, are generally available as a source of water. Many large industries in Chicago, which require large amounts of water at a low cost, have drawn heavily on these underground water resources.

WATER-BEARING FORMATIONS

Surface deposits. The surface water-bearing beds include unconsolidated sand, clay and gravel deposited directly or indirectly by the glaciers, and also the sand deposited in a larger lake, which preceded Lake Michigan. The constituent materials vary greatly both in size and character. The thickness around Chicago ranges from a very thin coating to over 100 feet.

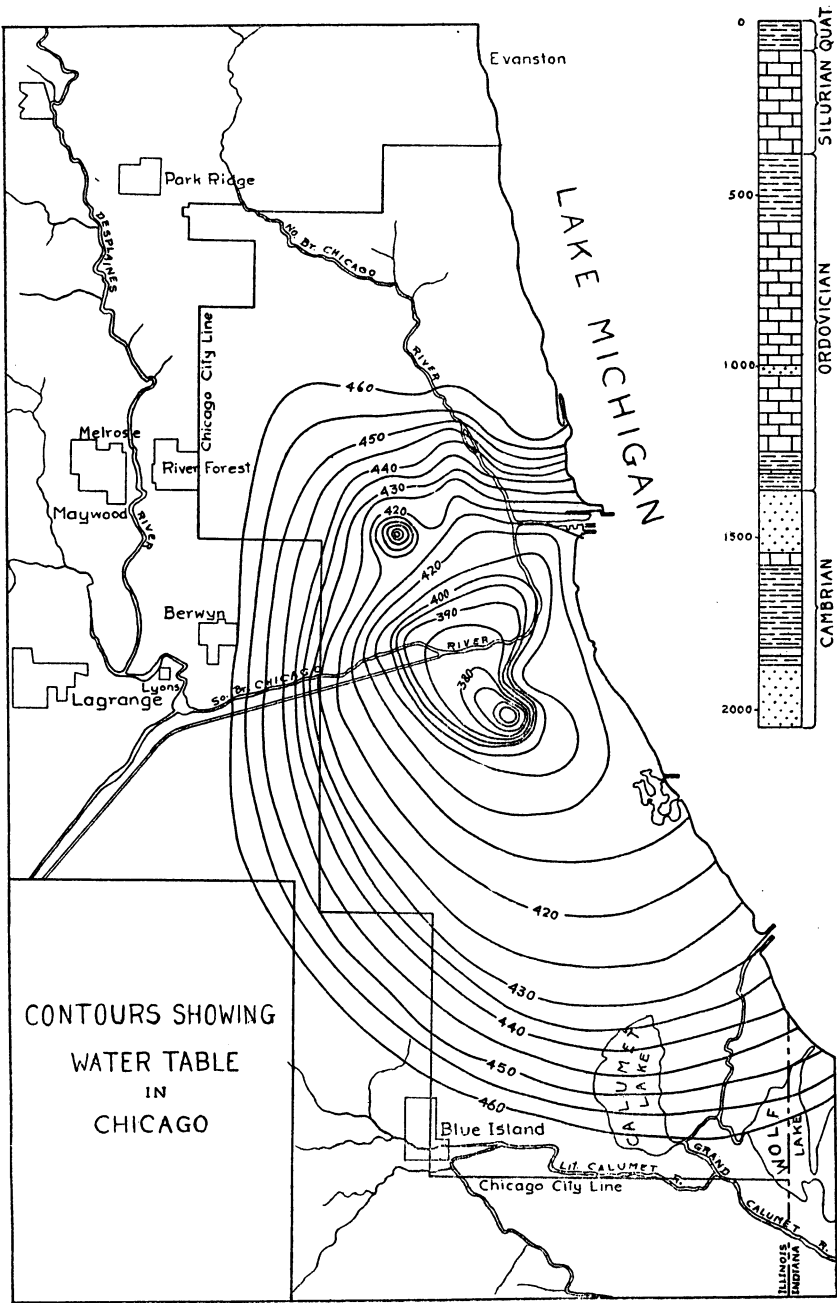
Wherever the surface materials are as thick as 100 or more feet, plenty of water can generally be obtained for domestic purposes, for small factories, or even for municipalities.

The only hard rock that outcrops at the surface is the Niagara limestone or "bed rock," which can be seen in many quarries in the vicinity of Chicago. The thickness varies between 150 and 300 feet, averaging about 250 feet. Locally, the Niagara contains considerable water, due to the presence of fissures and to a thick layer of porous drift which receives the rainfall. Such a belt extends north and south through Hinsdale, Illinois, and finally swings eastward and passes through Chicago Heights. Both of these cities obtain large amounts of good water from shallow rock wells.

Deep water supplies. The deeper formations underlying Northeastern Illinois are shown in Plate II. The Niagara is from 200 to 300 feet in thickness and is underlain by the fine-grained Maquoketa shale which is practically impervious to water. Other beds call for special mention:

Galena-Trenton limestone. The Galena-Trenton is a light gray, fine-grained dolomite or limestone which contains considerable magnesium carbonate. Fragments of chert nodules and a small amount of rounded quartz grains have also been found in the well drillings. The thickness varies from 300 to 450 feet. The first flow of water obtained in Chicago was from the Galena-Trenton limestone at a depth of 711 feet. The water rose to 80 feet above the surface or 111 feet above Lake Michigan.

St. Peter sandstone. The St. Peter sandstone formerly furnished great amounts of artesian water in Chicago. The thickness varies abruptly from 20 feet to over 250 feet, and the well driller may even report finding no sandstone at this horizon. The St. Peter sand was deposited on a very uneven surface of the Lower Magnesian limestone, which thus accounts for its great variation in thickness. The St. Peter is composed of a remarkably pure, well-rounded, siliceous sand.



The drilling of a large number of wells to the St. Peter sandstone resulted in an extremely heavy drain on these underground water resources. There were still flowing wells from this bed in Chicago during the early '90's, but at present it is impossible to obtain sufficient quantity of water from this formation for industrial purposes.

Lower Magnesian limestone. The Lower Magnesian lies next below the St. Peter sandstone. It is considerably fractured at a certain horizon about 1200 feet below the surface, and contains water in these fissures. The deep well at the Western Electric Company's plant, during the summer of 1912 was tested at this horizon, and yielded slightly over 200 gallons per minute without the water level being lowered over 10 feet.

Potsdam sandstone. The Potsdam sandstone generally means the first, heavy, sandstone member of the Potsdam series, sometimes called the Madison sandstone. It is found in Chicago at a depth of 1350 to 1400 feet. The first 100 feet is usually light brown, and is followed by 100 feet of a cream-colored sandstone. Below the Madison there is a somewhat sandy and shaly dolomitic limestone for another 200 feet. Underlying this limestone, other heavy beds of light brown, red, buff, or white sandstone, alternate with thin beds of dolomite and shale. The sand as a rule is coarser and not as well rounded as that of the St. Peter formation.

The Potsdam rocks are the oldest penetrated in the Chicago region and are known to a depth of at least 1000 feet.

The chief interest attaches to the Potsdam because it yields by far the greatest amount of artesian water used in the Chicago area. The main water-bearing stratum is the Madison, which wherever penetrated by a well of sufficient size, yields 300 and more gallons of water per minute.

ARTESIAN CONDITIONS

The term "artesian well" is applied to one whose original source of water is at a considerable distance, whether the well flows or not. This water has collected from rainfall in an area rather remote from the well, and has traveled under hydrostatic pressure through a porous bed until tapped at a point lower than the source.

The porous formations in this region are: the sandstones of the Potsdam series, the St. Peter sandstone, and to some extent the Lower Magnesian limestone. The Potsdam and the St. Peter are

the main water-bearing strata. They rise to the north and outcrop in south-central Wisconsin, at an altitude higher than that at Chicago.

The relatively impervious beds lying above the water-bearing formations prevent the escape of the waters until tapped by drilling. The overlying beds need not be entirely impervious provided they are filled with water, so that the downward pressure of the water is as great as the upward pressure of the water contained in the lower formations.

LOWERING OF WATER TABLE OF DEEP WELLS

Historical. The first artesian well was drilled in Chicago in 1864 at the corner of Chicago and Western avenues, and yielded a strong flow of water from the Galena-Trenton limestone at a depth of 711 feet. The water rose to 80 feet above the surface or 111 feet above Lake Michigan.

There were still flowing wells from the St. Peter in Chicago during the early '90's.

Since that time, with the increase in the number of wells drilled, there has been a gradual loss of hydrostatic pressure, even though the wells have been drilled deeper. At present all wells that furnish large quantities of water penetrate the Potsdam series. The water level has been lowered from 80 feet above the surface, so that now it is 220 feet below the surface when at rest, or 235 feet when pumping, in the stock yards district, where a large number of wells operate in a small area.

The greatest decline has been in the past 5 years during which time more large wells have been drilled than during any previous 5-year period.

A map with 10-foot contour interval has been prepared for the city of Chicago, showing the artesian water table as it was in October, 1914. The figures on contours indicate elevations above sea level. The hydrostatic pressure rises rapidly after leaving the stock yards, and then more gradually towards the outer parts of the city.

Effects of pumping. During the summer of 1914, when the greatest amount of water was being pumped in the stock yards district, the water level would fall to 232 feet below the surface. This would affect the area within a radius of one-half mile, even though certain wells would be idle. The lowest water level of 235 feet was measured in a large well pumping over 1500 gallons per minute. Meas-

urements obtained on many wells in this district showed that immediately after cessation of pumping there would be a gradual rise of about a foot in the first hour, and beyond that time no noticeable rise, even though the well was shut down for a number of hours. This was the case when the other wells in the stock yards were pumping to capacity. Measurements made, however, on a Sunday afternoon when only about half as much water was being pumped as on week days, showed a water level of 212 feet below surface, and indicated a rise of 20 feet.

Another example of the effect of pumping so large an amount of water was shown in a new well located about one-half mile from the group of largest wells. This well showed little water until the St. Peter sandstone was penetrated at about 900 feet, when the water rose to the general water level of the stock yards district. The St. Peter formation over other parts of Chicago no longer furnishes much water. The water from this new well was analyzed and found to be of the same character as that obtained from the deeper sands by other wells in this district. Thus it appears that the water from the Potsdam formations rises and enters the St. Peter sandstone, because of lack of casing in neighboring wells.

MINERAL CONTENT OF WATERS

The water obtained from the large producing wells in Chicago is a very hard, sulphate water, with mineral matter varying from 60 to over 100 grains per gallon. Wells deeper than 1800 feet encounter salt water, thus increasing the total mineral content to a very high amount. The water is primarily used for condensing and cleaning purposes.

Detailed analyses made by the State Water Survey of water from typical wells were presented in a paper last year by Mr. Anderson.